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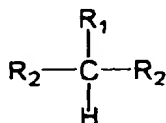
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(54) Carboxylic acid derivatives and their synthesis method

(57) This invention relates to novel carboxylic acid derivatives represented by the following formula I and their synthesis:

Formula I



wherein, R_1 is an hydrogen atom, an alkyl group or an alkoxy group of 1 to 20 carbon atoms in a linear,

branched or cyclic form; R_2 is a carboxy group of 1 to 40 carbon atoms in a linear, branched or cyclic form which is unsubstituted, or substituted into a hydroxy group, an ester group and an ether group.

The novel carboxylic acid derivatives are more easily decomposed by acid than t-butyl ester compounds but are not dissolved in basic aqueous solution. According to this invention, carboxylic acid is under condensation with halogen compounds designed to prepare a larger monomolecular compound compared to the conventional method. Further, the condensed site is easily decomposed by acid but is extremely insoluble by basic aqueous solution. The carboxylic acid derivatives in a photoresist composition function not only as a dissolution promoter in the exposed area due to formation of the carboxylic acid, thus enhancement of etching resistance and pattern profile in a resist.

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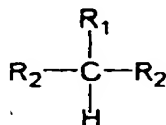
Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates to carboxylic acid derivatives and their synthesis method and more particularly, to novel carboxylic acid derivatives represented by the following formula I via introduction of some protecting group which can be easily decomposed by acid, including their synthesis method.

Formula I



wherein, R_1 is an hydrogen atom, an alkyl group or an alkoxy group of 1 to 20 carbon atoms in a linear, branched or cyclic form; R_2 is a carboxy group of 1 to 40 carbon atoms in a linear, branched or cyclic form which is unsubstituted, or substituted into a hydroxy group, an ester group and an ether group.

Description of the Related Art

[0002] As an additive or active ingredient of a resist, an electronic material, carboxylic acid compounds serve to improve the etching resistance and pattern profile of the resist.

[0003] It has been reported that one example of such carboxylic acid derivatives introducing t-butyl group as a protecting group includes t-butyl deoxycholate or t-butyl lithocholate (*Proc SPIE* 3049, 84, 1997).

[0004] However, the resist containing such carboxylic acid derivatives has recognized some disadvantages in that the insolubility of basic aqueous solution in a unexposed area cannot be overcome and the resist cannot be easily decomposed by acid.

[0005] In consequence, when the resist is developed for the final patterning using developer, the unexposed resist area is etched and this may lead to a poor pattern profile.

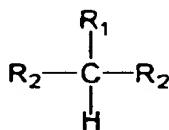
SUMMARY OF THE INVENTION

[0006] Therefore, an object of this invention is to provide novel carboxylic acid derivatives which have excellent combination of properties such as an easier decomposition by acid than the conventional t-butyl ester compounds including better insolubility in basic aqueous solution, so as to improve the etching resistance and pattern profile in a resist.

[0007] Another object of this invention is to provide a method for synthesizing the carboxylic acid derivatives.

[0008] To achieve the aforementioned objective, the carboxylic acid derivatives of this invention is characterized by the following formula I.

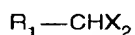
Formula I



wherein, R_1 is an hydrogen atom, an alkyl group or an alkoxy group of 1 to 20 carbon atoms in a linear, branched or cyclic form; R_2 is a carboxy group of 1 to 40 carbon atoms in a linear, branched or cyclic form which is unsubstituted, or substituted into a hydroxy group, an ester group and an ether group.

[0009] Further, this invention is characterized by a method of synthesizing the carboxylic acid derivatives represented by the formula I via reaction between a halogen compound represented by the following formula II and a carboxylic acid compound represented by the following formula III in the presence of a basic catalyst.

Formula II



Wherein, R_1 is the same as defined above; X is F, Cl, Br or I.

Formula III



Wherein, R_2 is the same as defined above.

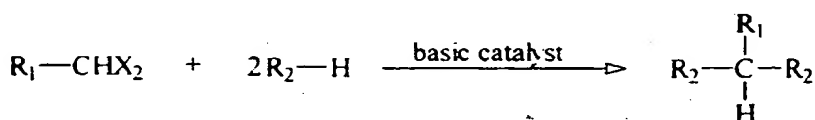
Detailed Description of the Invention

[0010] The carboxylic acid derivatives of this invention is synthesized via one-step reaction between a halogen compound represented by the compound II and a carboxylic acid compound represented by the formula III which are dissolved in an appropriate solvent and stirred with the slow addition of the basic catalyst.

[0011] Hence, the examples of the basic catalyst includes any of the general primary, secondary or tertiary amines, pyridines, organic metals or metals. However, in consideration of the fact that the base catalyst should contain a small amount of metal impurities as an electronic material, it is preferred that amine derivatives as organic basic catalyst is employed instead of metal catalysts.

The method for synthesizing the carboxylic acid derivatives of this invention can be represented by the following scheme 1:

Scheme 1



Wherein, R_1 , R_2 and X are the same as defined above.

[0012] According to this invention, the halogen compound represented by the formula II is 1,1-dihaloalkane or 1,1-dihaloalkyl alkyl ether, as defined above. The detailed examples of the halogen compound include dibromomethane, 1,1-dibromopropane, 1,1-dichloromethyl methyl ether and 1,1-dichloromethyl 2-norbbonyl ether; among them, the reactivity of 1,1-dibromopropane is somewhat poor than other halogen compounds.

[0013] From the carboxylic acid represented by the formula III of this invention, a majority of the aforementioned functional groups do not affect the reaction process. The detailed examples of functional group in the carboxylic acid include a hydroxy group, ester group, ether group, amide group, epoxy group, amino group, halogen group, lactone group, anhydride group and sulfide group. One or more of the functional groups in the carboxylic acid does not affect the reaction.

[0014] Reaction is generally performed at -80 to 150 °C. If the reaction temperature is extremely low, the starting materials are not well stirred. By contrast, if the reaction temperature is extremely high, some by-products may be generated.

[0015] Meantime, it is preferred that the reaction is performed for 0.5 to 15 hours.

[0016] It is preferred that 1.5 to 3.0 equivalents of the carboxylic acid represented by the formula III is employed to the halogen compound represented by the formula II, more preferably in the range of 1.8 to 2.2 equivalents.

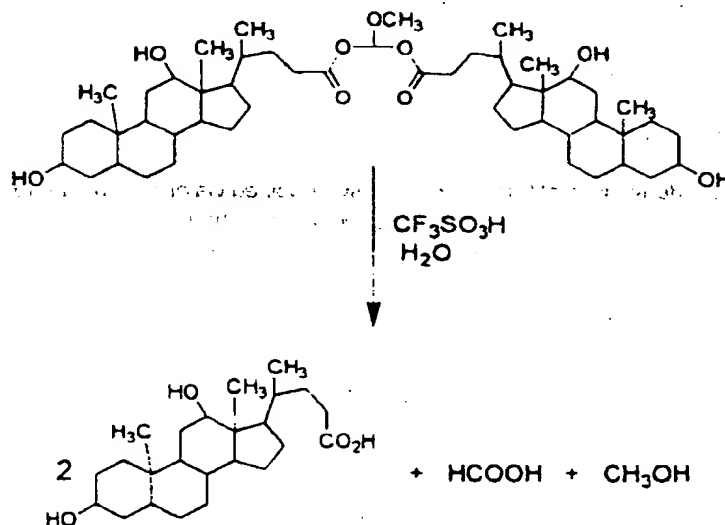
[0017] In case of synthesizing the carboxylic acid derivatives using the halogen compound, the reaction solvents includes dichloromethane, chloroform, carbon tetrachloride, acetonitrile, ethylacetate, ethylether, dioxane, dimethyl

formamide, dimethyl acetamide, ethanol, methanol, isopropanol or acetone; among them, it is preferred that dichloromethane and dimethyl formamide are employed. Hence, if any solvent can dissolve the halogen compound represented by the formula II and carboxylic acid represented by the formula III or can be dissolved in the reaction mixture without dissolving these starting materials, there are no special restriction in using the solvent.

[0018] Based on the carboxylic acid derivatives, so synthesized by the above mentioned, a photoresist composition can be prepared using a basic resin, photo-acid generator, and some additive. Hence, the carboxylic acid derivatives serves to improve various properties such as etching resistance, adhesiveness, pattern profile, resolution and exposure energy.

[0019] From the newly synthesized carboxylic acid derivatives of this invention, the reaction mechanism of deoxycholic acid derivatives decomposed by strong acid is shown in the following scheme 2.

Scheme 2



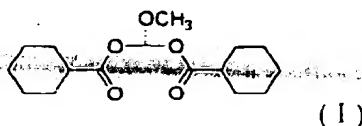
[0020] From the above scheme 2, the deoxycholic acid derivatives has an extremely low solubility to basic aqueous solution but the deoxycholic acid generated from the acid-decomposition has an extremely high solubility to basic aqueous solution.

[0021] Under the above principle, the deoxycholic acid derivative in a chemical-amplified resist function not only as a dissolution inhibitor on basic aqueous solution in the unexposed area but also as a dissolution promoter on basic aqueous solution in the exposed area due to formation of the deoxycholic acid.

[0022] This invention is explained based on the following examples but is not confined to these examples.

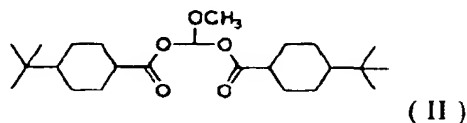
Example 1

[0023] α, α -dichloromethyl methylether (10g) was slowly added to cyclohexane carboxylic acid (22.3g) dissolved in dimethyl acetamide at 0 °C. With the slow addition of triethylamine (19.4g), the reaction mixture was stirred at the same temperature for 1 hour and further stirred for 2 hours at room temperature. After the reaction was completed, the reaction mixture was diluted with ethyl acetate, washed with excess of distilled water three times, washed again with a potassium carbonate solution and distilled water. After separating the organic layer, the solution was dried over magnesium sulfate and filtered off. With the complete removal of solvent contained in the remaining solution under vacuum distillation, 25g of the following compound (I) was obtained.



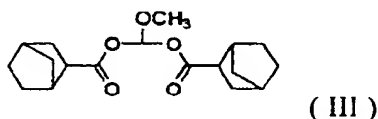
Example 2

[0024] Carboxylic acid derivative was prepared in the same manner as Example 1 using 4-tert-butylcyclohexane carboxylic acid(32.1g) instead of cyclohexane carboxylic acid(22.3g), thus obtaining 32g of the following compound (II).



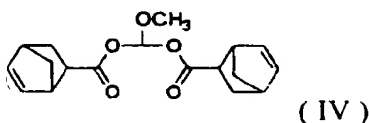
Example 3

[0025] Carboxylic acid derivative was prepared in the same manner as Example 1 using norbornane carboxylic acid (24.4g) instead of cyclohexane carboxylic acid(22.3g), thus obtaining 26g of the following compound (III).



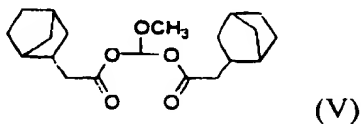
Example 4

[0026] Carboxylic acid derivative was prepared in the same manner as Example 1 using norbornene carboxylic acid (24.0g) instead of cyclohexane carboxylic acid(22.3g), thus obtaining 24g of the following compound (IV).



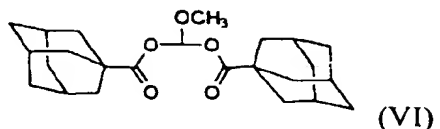
Example 5

[0027] Carboxylic acid derivative was prepared in the same manner as Example 1 using norbornane acetic acid (26.8g) instead of cyclohexane carboxylic acid(22.3g), thus obtaining 27g of the following compound (V).

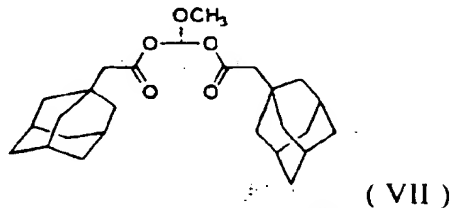


Example 6

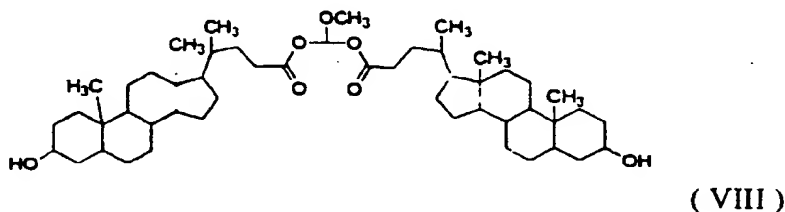
[0028] Carboxylic acid derivative was prepared in the same manner as Example 1 using 1-adamantane carboxylic acid(31.4g) instead of cyclohexane carboxylic acid(22.3g), thus obtaining 28g of the following compound (VI).

**Example 7**

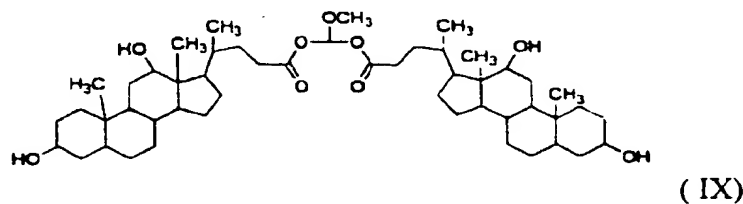
[0029] Carboxylic acid derivative was prepared in the same manner as Example 1 using 1-adamantane acetic acid (33.8g) instead of cyclohexane carboxylic acid(22.3g), thus obtaining 31g of the following compound (VII).

**Example 8**

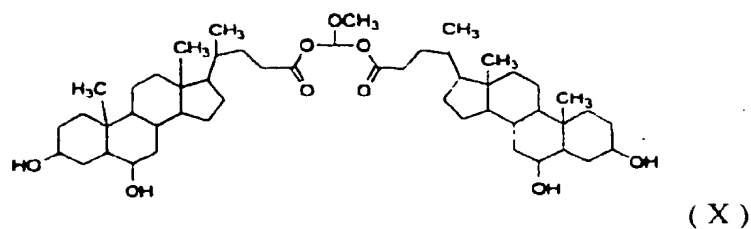
[0030] Carboxylic acid derivative was prepared in the same manner as Example 1 using lithocholic acid(65.5g) instead of cyclohexane carboxylic acid(22.3g), thus obtaining 59g of the following compound (VIII).

**Example 9**

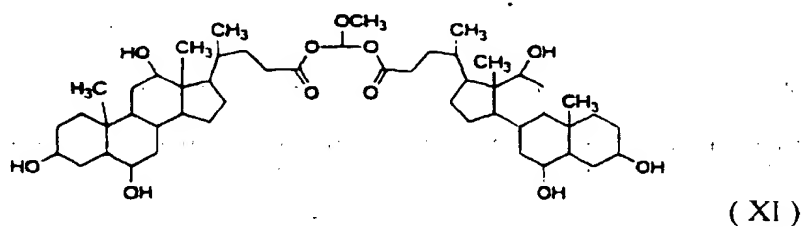
[0031] Carboxylic acid derivative was prepared in the same manner as Example 1 using deoxycholic acid(68.3g) instead of cyclohexane carboxylic acid(22.3g), thus obtaining 60g of the following compound (IX).

**Example 10**

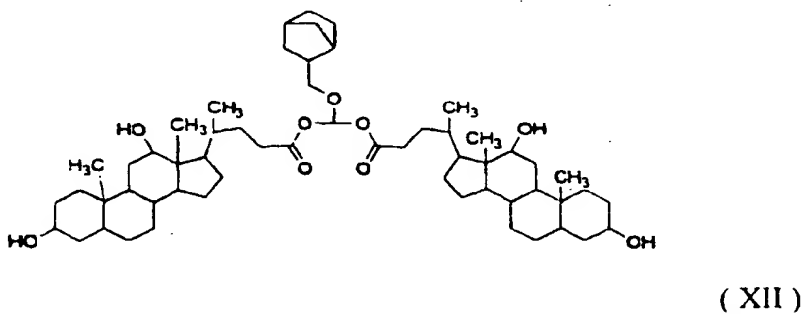
[0032] Carboxylic acid derivative was prepared in the same manner as Example 1 using hyodeoxycholic acid(68.3g) instead of cyclohexane carboxylic acid(22.3g), thus obtaining 63g of the following compound (X).

**Example 11**

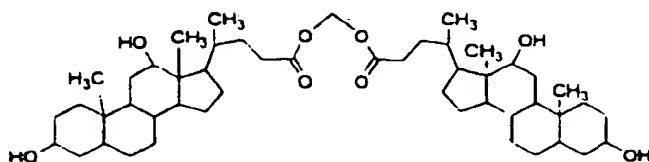
[0033] Carboxylic acid derivative was prepared in the same manner as Example 1 using cholic acid(71.1g) instead of cyclohexane carboxylic acid(22.3g), thus obtaining 60g of the following compound (XI).

**Example 12**

[0034] Carboxylic acid derivative was prepared in the same manner as Example 1 using deoxycholic acid(68.3g) instead of cyclohexane carboxylic acid(22.3g) and α , α -dichloromethyl 2-norbomanemethyl ether(18g) instead of α , α -dichloromethyl methyl ether(10g), thus obtaining 59g of the following compound (XII).

**Example 13**

[0035] Carboxylic acid derivative was prepared in the same manner as Example 1 using deoxycholic acid(68.3g) instead of cyclohexane carboxylic acid(22.3g) and diiodomethane(23g) instead of α , α -dichloromethyl methyl ether (10g), thus obtaining 53g of the following compound (XIII).



(XIII)

Experimental examples 1 to 2 and comparative experimental examples 1 to 2

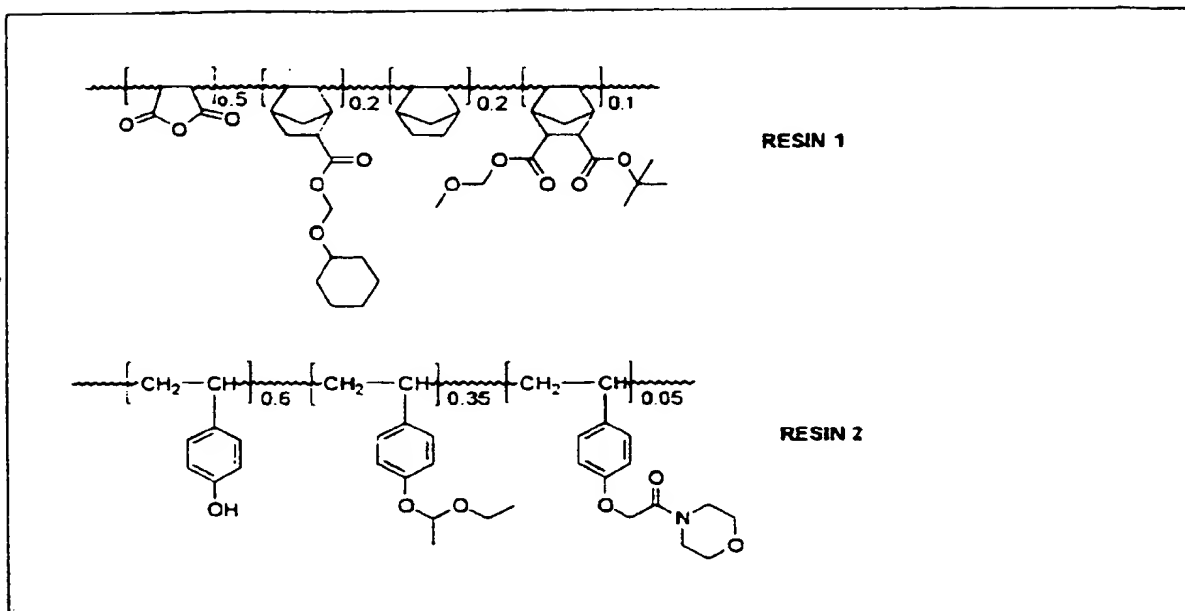
[0036] As shown in the following table 1, some components were dissolved and filtered by a 0.2um membrane filter to obtain a resist solution. The remaining solution was coated on silicon wafer by rotation. The coated wafer was heated at 110 °C for 60 seconds. The wafers derived from Experimental example 1 and Comparative experimental example 1 was exposed by a ArF exposure system (ISI small field exposure system) and heated at 110 °C for 60 minutes. Then, the wafers were developed using an aqueous hydroxide solution for 60 minutes and dried to obtain a positive resist pattern.

[0037] Hence, the etching resistance is a relative figure based on i-line using -----.

[0038] According to Experimental example 2 and Comparative experimental example 2, the wafers were exposed by a Nikon KrF stepper.

Table 1.

Category	Composition	Resolution (um)	Etching resistance
Experimental example 1	Resin 1:20g Compound of Example 9: 4g Triphenylsulfonium trifluoromethane sulfonate: 0.36g Triethylamine: 0.018g Propyleneglycol monomethylether acetate: 140g	0.13	1.8
Comparative Experimental example 1	Resin 1:24g Triphenylsulfonium trifluoromethane sulfonate: 0.36g Triethylamine: 0.018g Propylene glycol monomethylether acetate: 140g	0.15	2.3
Experimental example 2	Resin 2: 20g Compound of Example 9: 4g Triphenylsulfonium trifluoromethane sulfonate: 0.72g Triethylamine: 0.036g Propylene glycol monomethylether acetate: 120g	0.18	1.9
Comparative Experimental example 2	Resin 2: 24g Triphenylsulfonium trifluoromethane sulfonate: 0.72g Triethylamine: 0.036g Propylene glycol monomethylether acetate: 120g	0.20	2.4

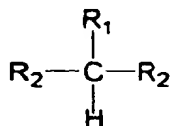


[0039] As described above, the carboxylic acid derivatives of this invention, so prepared via condensation between carboxylic acid compound and halogen compounds, have several advantages in that (1) they are easily decomposed by acid but are not dissolved by basic aqueous solution, (2) more large monomolecular compound can be prepared. The carboxylic acid derivatives in a photoresist composition function not only as a dissolution inhibitor in the unexposed area to improve a dark erosion but also as a dissolution promoter in the exposed area due to formation of carboxylic acid, thus enhancement of pattern profile in a resist.

Claims

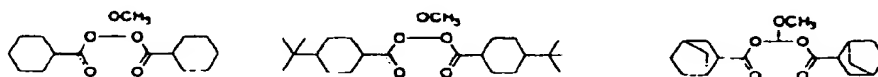
1. Carboxylic acid derivatives represented by the following formula I:

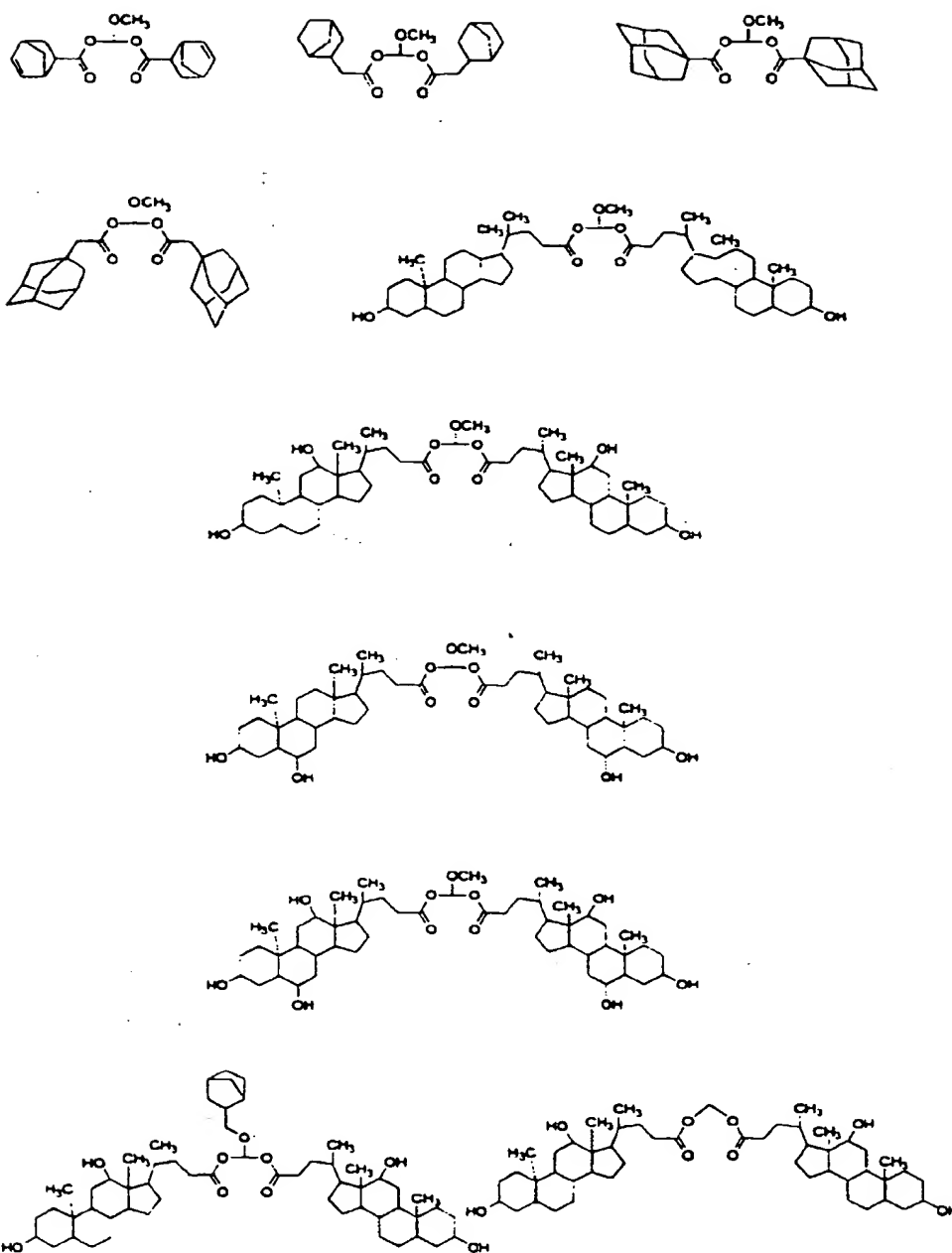
Formula I



wherein, R_1 is an hydrogen atom, an alkyl group or an alkoxy group of 1 to 20 carbon atoms in a linear, branched or cyclic form; R_2 is a carboxy group of 1 to 40 carbon atoms in a linear, branched or cyclic form which is unsubstituted, or substituted into a hydroxy group, an ester group and an ether group.

2. Carboxylic acid derivatives according to claim 1, selected from the group consisting of the following compounds:





3. A method for synthesizing carboxylic acid derivatives represented by the formula I, wherein one or more of the selected halogen compounds represented by the following formula II is/are reacted with one or more of the selected carboxylic acid compounds represented by the following formula III (1.5 to 3.0 equivalents to the halogen compound represented by the formula II) at -80 to 150 °C for 0.5 to 15 hours in the presence of a basic catalyst.

Formula II



Wherein, R₁ is the same as defined above; X is F, Cl, Br or I.

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Formula III



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Wherein, R_2 is the same as defined above.

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4. The method according to claim 3, wherein said basic catalyst is selected from the group consisting of amine, pyridines, organic metals, metals and mixture thereof.

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